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ABSTRACT

It is not necessary for students to learn about numbers and number operations before effectively using calculators; rather that such understanding and skill follows naturally from appropriate access to technology. Students using calculators and computers demonstrate improved attitudes toward mathematics, increased confidence in their problem solving abilities, are more willing to take risks, and appear more adaptable in the use of technology than their teachers. Also, the more effective lessons involving technology appear to be those in which students work cooperatively rather than individually or competitively. These findings and concerns produced the following five recommendations presented in this statement: (1) all students should have ready access to appropriate technology to support and extend their mathematics learning; (2) priority should be given to the use of calculators and computers as natural media for mathematics; (3) teachers at all levels should be involved in the potential use of technology for mathematics learning; (4) students who use calculators and computer technology in their learning of mathematics should have access to the same technological resources when their understanding of mathematics is being evaluated; and (5) education authorities need to make available to teachers professional development opportunities to support their use of calculator and computer technologies in the classroom. The issues of student learning, teaching practice, equity, assessment, and curriculum are also addressed. (AIM)

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Statement on the Use of Calculators and Computers for Mathematics in Australian Schools

1996

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It is recommended that:

1. **All** students have ready access to appropriate technology as a means both to support and extend their mathematics learning experiences;
2. Priority be given to the use of calculators and computers as natural media for mathematics learning within a technologically-rich learning environment;
3. Teachers at all levels be actively involved in exploring ways to take full advantage of the potential of technology for mathematics learning within the total curriculum;
4. Students who use calculator and computer technology in their learning of mathematics have access to the same technological resources when their understanding of mathematics is being evaluated;
5. Education authorities make available to teachers professional development opportunities to support the development of knowledge and skills necessary for the successful use of calculator and computer technologies in classrooms.

AAMT Australian Association of Mathematics Teachers Inc.

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I. BACKGROUND

An important feature of mathematics has been its use of physical and intellectual tools. Computers represent a truly generic tool, limited in application only by the imagination of the user.

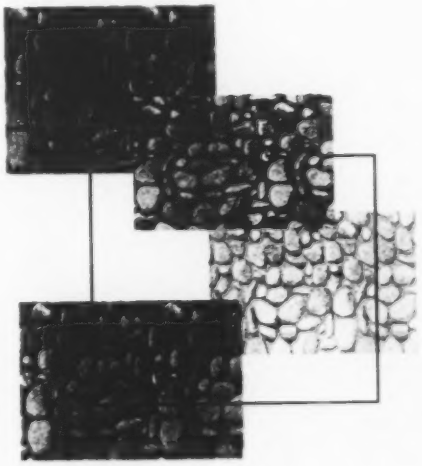
Mathematics education must reflect the influence of technology upon both mathematics and society. This new technology demands new interpretations of the instructional process and those charged with educating the next generation must engage in a continual cycle of evaluation and re-evaluation in the light of technological influence at all levels.

This statement updates and extends the *National Statement on the Use of Calculators for Mathematics in Australian Schools*, published in 1987 and endorsed by all Australian education systems. While the direction and recommendations of this earlier Statement remain valid, it is necessary to elaborate upon this document to better reflect the following factors:

- the broader nature of the technological resources now available (including the development of pedagogically significant computer software at all levels of schooling and powerful new technologies, such as the graphics calculator);
- the significant changes to schooling and society which have marked the intervening years, including widespread accessibility of computers in homes and schools for many communities across Australia, and
- the results of research which increasingly inform our knowledge and understanding of teaching and learning in a technological world.

The National Statement on Mathematics for Australian Schools (1991) and *Mathematics - a curriculum profile for Australian schools* (1994) offer a framework for the development of the mathematics curriculum in all states and territories. Both make frequent reference to the role of calculators and computer technology within mathematics education in the context of an increasingly technological society. Such is the significance of this aspect of the discipline that this document addresses the associated issues and implications in detail.

The issues addressed in this statement are relevant to all parties with a stake in the educational process, particularly as it applies to mathematics education. Teachers, students, parents, schools, educational systems and policy-makers, employers and community bodies need to reflect upon the issues and challenges of technology in this context. It is the purpose of this statement to clarify and direct such reflection.



II. WHAT IS CALCULATOR AND COMPUTER TECHNOLOGY?

The focus of this document is upon the technological resources available for mathematics teaching and learning, which specifically include computer hardware and software, in addition to the growing range of peripherals, which include video, CD-ROM and electronic communications media. Within the context of mathematics learning, the division between calculators and computers has become increasingly blurred. Calculators may no longer be distinguished from computers by their hand-held nature; they may be thought of as *specific-purpose* computing tools for mathematics which now range from simple four-function models to scientific aids, likely to include graphing, equation solving and even symbolic manipulation capabilities. Computers, on the other hand, are general in nature, functionally defined by their software, and now include hand-held devices which have been specifically designed with the needs of mathematics in mind.

Mathematical activities involving computer technologies at all levels include:

- communicating
- mathematical modelling
- searching, retrieving, analysing and presenting information
- manipulating numbers, symbols and shapes
- representing mathematical ideas and processes using a variety of forms
- estimating and judging the reasonableness of results
- investigating patterns and problems.

Appropriate computer technology places users in control of their own learning. It encourages both independent and collaborative learning while extending and supporting the learning process.

Software tools appropriate to mathematics learning at all levels will include word processing, data base, drawing, painting and communications software. In addition, more specifically mathematical software, such as LOGO, spreadsheets, graph plotters, symbol manipulators, dynamic geometry and statistics packages are now available. Students at all levels should have access to a wide range of such resources as aids to computation, exploration and enhancement of their appreciation and enjoyment of the diverse yet integrated nature of mathematics.

Interactive packages which support appropriate simulation and representation of real-world activities within a mathematical framework - encouraging, for example, student measurement, estimation and interpretation - appear to offer particular promise as tools for building mathematical understanding.

The rapidly changing nature of computer technology continues to expand the range of resources available for mathematics learning. Educators must be imaginative, flexible, and willing to renew their visions of teaching and learning if they are to fully realise the potential of educational technology.

III. IMPLICATIONS FOR SCHOOL AND CLASSROOM PRACTICE

Beginning Years (Band A) ...

Young children respond quickly and naturally to appropriate technologies, which frequently offer a high level of physical control and immediate feedback in a variety of forms. Access to a basic calculator is required for ALL students as a most significant means for introducing and developing number sense. Use of technology enhances effectiveness of a learning experience which may embrace, among other things, problem solving, letter, number, symbol and pattern recognition, word meaning and number sense.

Middle and Upper Primary (Band B) ...

Increasingly, children at this level will assume responsibility for their own learning. Their interactions with available technological resources should frequently demonstrate purpose and deliberation, exploring the effects of mathematical actions and, later, ideas in non-threatening and supportive ways. Calculators as personal tools must be available at all times, and classroom access to at least one computer at all times is recommended.

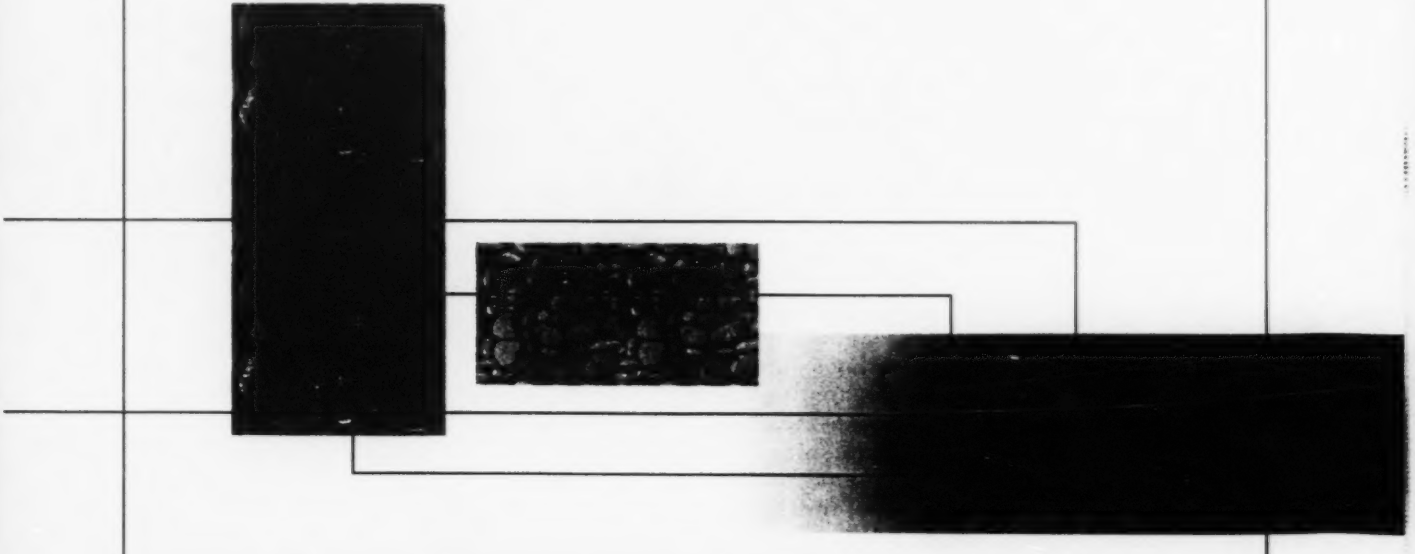
The Lower Secondary Years (Band C) ...

Students at this level should be encouraged to use technological tools as a means for investigating mathematical processes situated within meaningful contexts (often derived from real-world data). Unrestricted access to a scientific calculator at this level is required.

Upper Secondary & beyond (Band D) ...

Technological resources (especially the graphics calculator) underpin much of the mathematics studied at this level. Appropriate computer resources (especially graphics calculators) must be readily available. Iterative processes and approximation methods should stand alongside traditional symbolic approaches; deduction and reasoning should be framed within a technological context, and analysis of data assumes equal importance with traditional analytical methods. As more students extend the term of their formal education, the scaffolding role of technology becomes increasingly significant.

Frequent access to graphics calculators, and the presence of at least one computer for classroom use is strongly recommended.



IV. SOME CRITICAL ISSUES

Student Learning

Students of mathematics at all levels must be encouraged to become intelligent and critical users of technology, able to make informed decisions on the use of different mathematical strategies. Such decisions include *when* to use available technology, and *which technology* is most appropriate to the task. Students must develop an awareness of the *limitations* of the approach chosen, and a readiness to adapt and respond to technological changes.

Teaching Practice

Traditional instructional approaches must be reassessed in light of the increasing influence of technology. The effective use of technology encourages a move away from teacher-centred approaches and towards a more flexible and student-centred environment.

A *technology-rich learning environment* is characterised by collaborative and investigative approaches to learning, increasing integration of content across the curriculum and a significant emphasis upon concept development and understanding. The balance of power changes, too, as teachers and students become co-learners through the use of technological tools.

Equity

Every care must be taken to ensure that the use of technology does not contribute to increased inequity among individuals and groups already recognised as being disadvantaged by reason of race, gender, disability or socio-economic status. Some students will have prior experience of computers which may be quite extensive, and will have developed confidence and facility in their use. Schools need to provide opportunities for less experienced students to develop familiarity and skills in the use of required technologies within a supportive and non-threatening environment. All students require individual as well as group access to technological resources. It should be noted that delaying the official recognition and requirement for the use of technological resources until they are considered to be affordable for all may itself be a source of inequity, since better resourced segments of the community then have access while others do not.

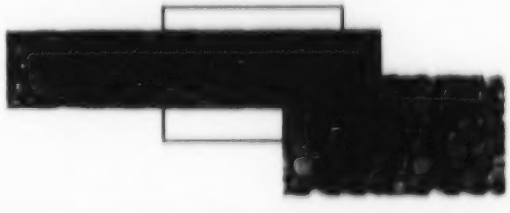
Assessment

Assessment practice should reflect good teaching practice. The use of technological resources as integral aids to learning assumes their inclusion in the assessment process. New approaches to assessment will be required at all levels to better reflect the realities of learning within a technological society.

The Curriculum

The influence of technology emphasises the importance of some aspects of curriculum content (such as discrete mathematics and chaos theory) and process (such as estimating, approximating, evaluating results), while diminishing the role of others (such as repetitive algorithms and rote learning). It implies a fundamental shift in educational priority, from accumulating knowledge to the management of information, and suggests an increasing need for citizens who are informed, critical and capable as decision-makers in a technological world.

Curriculum documents must reflect such social changes in educational priority and herald subsequent changes in pedagogy. Curriculum documents, by making specific reference to calculator and computer technology, drive their implementation and encourage the acceptance of innovation at the classroom level. Such documents should provide both models of good practice and specific instances of exemplary use of technology as applied both to curriculum content and the pedagogical process.



V. WHAT DOES RESEARCH TELL US?

- Students who use calculators and computers *within an appropriate instructional environment* can improve their basic skills by increasing their number sense and strengthening their understanding of arithmetic operations. It is NOT necessary for students to learn about numbers and number operations before they can effectively use calculators; rather, such understandings and skills follow naturally from appropriate access to technology.
- Across all grades and ability levels, students who use calculators and computers demonstrate improved attitudes towards mathematics and increased confidence in their mathematical ability.
- Students using technological tools are likely to show greater persistence and effectiveness in trying to solve problems, and appear more willing to take risks.
- The most effective lessons involving technology appear to be those in which students work cooperatively rather than competitively or individually.
- Students (including very young children) appear more adaptable in the use of technology than their teachers.

The Australian Association of Mathematics Teachers Inc.
GPO Box 1729
Adelaide South Australia 5001
Telephone **(08) 8363 0288**
Facsimile **(08) 8362 9288**
E-mail **aamtinc@nexus.edu.au**
Web **http://www.aamt.edu.au**

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